

## TAXONOMIC STUDIES ON ASTER L. (COMPOSITAE)

Kadria A. Ahmed, Azza M.F. Khafagi and A. El-Gazzar

Botany Dept., Faculty of Science for Girls, Al-Azhar Univ., Cairo, Egypt. and College of Agricultural Sciences and Food, King Faisal Univ., P.O. Box 380, Hofuf, Saudi Arabia.

### ABSTRACT

Variation in a set of 41 characters from vegetative morphology, stem anatomy, epidermal trichomes of the outer involucre bracts and achenes, pappus type as well as the distribution of trichome types and forms of calcium oxalate crystals in the different parts of ray and disc florets was recorded comparatively for each of 37 species and infra-specific taxa of Aster L. The data-matrix was used to construct a non-indented dichotomous key to these taxa.

### INTRODUCTION

Aster L. is the type genus of Compositae (Asteraceae), comprising ca. 500 species of which nearly 50% are concentrated in North America. Despite recent intensive efforts by numerous authors (e.g. Fernald, 1950; Munz, 1968; Merxmuller, Schreiber and Yeo, 1976; Lippert, 1973 and 1980; Rommel 1977 and 1979), the circumscription of Aster remains a subject for much taxonomic controversy. Relationships of Aster to other genera (e.g. Erigeron, Tripolium, Galatella, Calimeris, Sericocarpus, Callistephus, Amellus, Biotia, Eremiastrum, Heliastrum, Corethrogyne, Machaeranthera, Olearia) have for long been a source of wide discrepancies between taxonomic accounts of the family (e.g. Hoffmann, 1894; Bentham and Hooker, 1876; De Candolle, 1836; Lindley, 1853). While some authors regarded some or all of these genera as separate from Aster, others treated them wholly or partly as its subgenera. Furthermore, within Aster the species continue to be notoriously difficult to identify. It is believed that this difficulty is due primarily to the almost total lack of comparative observations recorded consistently for each species. The present study attempts, therefore, to construct an identificatory key based on the widest possible range of comparative aspects of variation exhibited by a reasonably representative sample of the genus sensu lato (see Table 1).

### OBSERVATION

No a priori limitations have been imposed on the sources of observations; provided the range of variation in a character lends itself to accurate definition into

**Table 1:** List of 37 taxa of Aster sensu lato included in the present study.

No.	taxa	No.	taxa
1.	<i>Aster acris</i> L.	28.	<i>A. sagittifolius</i> .
2.	<i>A. acuminatus</i> Michx.		Wedemyer f. <i>hirtellus</i>
3.	<i>A. adscendens</i> Lindl.		(Lindl.) Shinnery.
4.	<i>A. alpinus</i> L.	29.	<i>A. salicifolius</i> . Ait.
5.	<i>A. allaicus</i> Willd.	30.	<i>A. simplex</i> Willd.
6.	<i>A. amellus</i> L.	31.	<i>A. spectrabilis</i> Ait.
7.	<i>A. bellidiastrum</i> Scop.	32.	<i>A. suamatus</i> (Sprengel)
8.	<i>A. chinensis</i> L. (- <i>Callistephus</i> )		Hieron.
9.	<i>A. cinereus</i> Kotsch.	33.	<i>A. subulatus</i> Michx.
10.	<i>A. cordifolius</i> L.	34.	<i>A. tenebrosus</i> Burgess
11.	<i>A. divaricatus</i> L.	35.	<i>A. tripolium</i> L.
12.	<i>A. ericoides</i> L.	36.	<i>A. umbellatus</i> Mill.
13.	<i>A. laevis</i> L.	37.	<i>A. undulatus</i> L.
14.	<i>A. lateriflorus</i> (L.) Britt.		
15.	<i>A. linosyris</i> Bernh.		
16.	<i>A. longicaulis</i> Desf. ex DC.		
17.	<i>A. lowrieanus</i> Porter.		
18.	<i>A. macrophyllus</i> L.		
19.	<i>A. nemoralis</i> Ait.		
20.	<i>A. novae-angliae</i> L.		
21.	<i>A. novi-belgii</i> L.		
22.	<i>A. patens</i> Ait.		
23.	<i>A. prenanthoides</i> Muhl.		
24.	<i>A. punctatus</i> Waldst et Kit.		
25.	<i>A. puniceus</i> L.		
26.	<i>A. radula</i> Ait.		
27.	<i>A. sagittifolius</i> Wedemyer.		

a number of character states, it has been included among the list of attributes (Table 2) forming the basis of the intended key. It is evident from Table 2 that the 41 characters have been taken from such diversified sources as gross vegetative morphology, stem anatomy, epidermal trichomes and mesophyll structure of the outer involucreal bracts and achenes, pappus type, and the distribution of epidermal trichome types and forms of calcium oxalate crystals in the different parts of ray flowers (RF) and disc flowers (DF). The comparative recording of all 41 characters for each of the 37 *Aster* species and infra-specific taxa is given in Table 3. Although all characters are easy to observe, some are illustrated in Figs. 1-23.

#### THE KEY

There follows a non-indented dichotomous key to the 37 taxa of *Aster* under investigation. This is by no means intended to be the last word on the identification of asters, but merely an example of how to overcome the seemingly unsurmountable identificatory problems involved with relatively large assemblages of species from this genus, through the consistent recording of characters in the fashion shown in Table 3. Furthermore, the data-matrix presented in Table 3 is a permanent record of the species and their characters. Such data-matrix can be easily expanded to cover a much wider range of characters and/or species. The following key has been synthesized manually, but the data-matrix on which the key is based may also be subjected to some of the computer programmes designed for key construction, thus saving the greater part of the time and effort expended on the process.

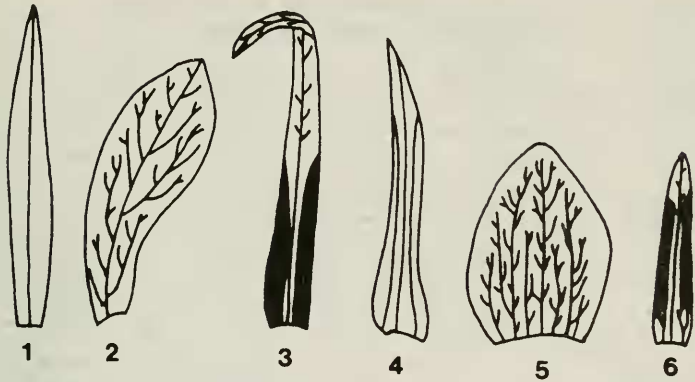
**Table 2:** List of 41 characters recorded comparatively for 37 taxa of *Aster sensu lato*. Symbols (+, -) or serial numbers are assigned to Character-states and used to denote them in the data-matrix (in Table 3). \* = a character-state is missing or inapplicable.

---

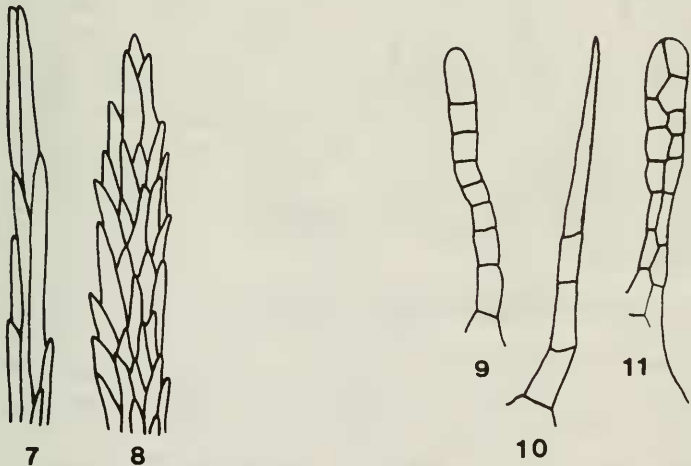
1. Stem:	Present +/ absent (dwarf) -.
2.	Schizogenous canals in cortex, present +/ absent - (inapplicable if stem absent).
3.	schizogenous canals in phloem, present +/ absent - (inapplicable if stem absent).
4.	pith solid +/ hollow - (inapplicable if stem absent).
5.	pith parenchymatous +/ lignified - (inapplicable if stem absent).
6. Indumentum:	glabrous +/ grey-canescens -.
7. Leaves:	margin entire +/ not so -.
8.	petiolate 1/ sessile 2/ decurrent 3.
9.	length/breadth ratio of blade (L/B ratio).
10.	apex acute 1/acuminate 2/obtuse 3.
11. Bracts:	one-nerved +/ many-nerved -.
12.	vein(s) branched +/ unbranched -.
13.	fibres in mesophyll abundant +/few or absent -.
14.	glandular hairs present +/absent -.
15.	eglandular hairs present +/absent -.
16.	appendaged hairs present +/ absent -.
17.	entangled hairs present +/absent -.
18. Capitula:	solitary terminal +/in aggregates -.
19.	corymbose +/ otherwise - (inapplicable if solitary terminal *).
20. Pappus:	apex 2-celled +/ more than 2-celled -.
Ray flowers:	(R.F.):
21.	glandular hairs on petals present +/ absent -.
22.	eglandular hairs on petals present +/ absent -.
23.	glandular hairs on achene present +/ absent -.
24.	eglandular biseriate hairs on achene present +/ absent -.
25.	rosette crystals in testa present +/ absent -.
26.	prismatic crystals in testa present +/ absent -.
27.	rosette crystals in achene present +/ absent -.
28.	prismatic crystals in achene present +/ absent -.

29.                    rosette crystals in style present +/  
                      absent -.
30.                    prismatic crystals in style present+/  
                      absent -.
- Disc flowers       (D.F.):
31.                    glandular hairs on petals present +/  
                      absent -.
32.                    eglandular hairs on petals present+/  
                      absent -.
33.                    staminal auricle present +/ absent -.
34.                    glandular hairs on achene present +/  
                      absent -.
- 35                    eglandular biseriate hairs on achene  
                      present +/ absent -.
36.                    rosette crystals in testa present +/  
                      absent -.
37.                    prismatic crystals in testa present  
                      +/ absent -.
38.                    rosette crystals in achene present+/  
                      absent -.
39.                    prismatic crystals in achene present  
                      +/ absent -.
40.                    rosette crystals in style present +/  
                      absent -.
41.                    prismatic crystals in style present  
                      +/ absent -.

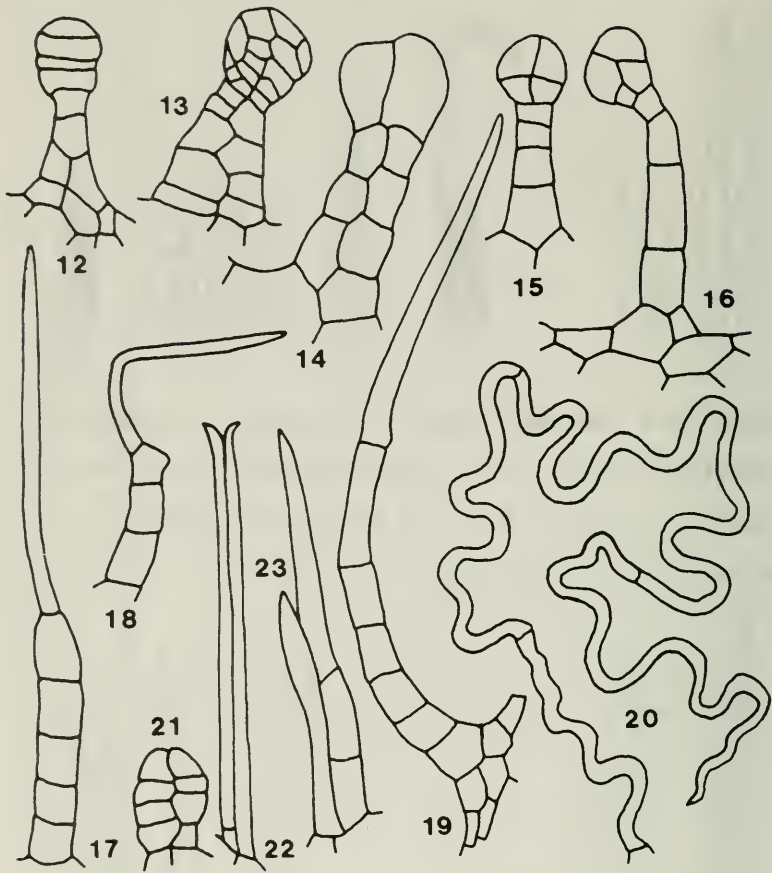




**Figs. 1-6. Morphology of outer involucre bracts.** Figs. 1-3, one-nerved; Figs. 4-6, many-nerved; Figs. 3 & 6, with patches of fibres in mesophyll.



**Figs. 7 & 8. Pappus Hairs.** **Figs. 9-11. Petal Hairs.**  
 Fig. 7, 2-celled apex; Figs. 9 & 10, eglandular.  
 Fig. 8, many-celled apex. Fig. 11, glandular.



**Figs. 12-20. Epidermal trichomes of outer involucre bracts.** Figs. 12-16, glandular hairs; Figs. 17 & 18, appendaged hairs; Fig. 19, egladular hair; Fig. 20, entangled hair.

**Figs. 21-23. Hairs on achenes.** Fig. 21, glandular; Figs. 22 & 23, biseriate egladular.



**A non-indented dichotomous key to the 37 taxa  
of Aster under investigation**

- |   |                         |
|---|-------------------------|
| 1. Plants grey-canescens, with entangled hairs .....  | <u>A. cinereus</u>      |
| plants glabrous, without entangled hairs .....  | 2                       |
| 2. Capitula solitary terminal .....   | 3                       |
| Capitula in aggregates .....  | 6                       |
| 3. Bracts several-nerved, with fibrous mesophyll; canals in cortex .....                                      | <u>A. alpinus</u>       |
| Bracts uninerved, without fibres; no canals in cortex .....   | 4                       |
| 4. Anthers auricled, bracts with glandular hairs .....  | <u>A. altaicus</u>      |
| Anthers not auricled, bracts without glandular hairs .....  | 5                       |
| 5. Leaf-margin entire, pappus apex <u>2-celled.</u>   | <u>A. chinensis</u>     |
| Leaf-margin toothed, pappus apex with more than 2 cells .....   | <u>A. bellidiastrum</u> |
| 6. Pith hollow .....  | 7                       |
| Pith solid .....  | 11                      |
| 7. Cortex without canals; pith lignified  | <u>A. umbellatus</u>    |
| Canals in cortex; pith parenchymatous   | 8                       |
| 8. L/B ratio of leaves at least 17 .....  | <u>A. tripolium</u>     |
| L/b ratio 2-8 .....   | 9                       |
| 9. Bracts with simple veins and no fibres; achenes with biseriate eglandular hairs; anthers auricled .....    | <u>A. nemoralis</u>     |
| Bracts with branched veins and fibres; achenes without biseriate eglandular hairs; anthers not auricled ..... | 10                      |
| 10. Leaves sessile; glandular hairs on leaves, bracts and achenes .....                                       | <u>A. squamatus</u>     |
| Leaves petioled; eglandular hairs on leaves and bracts; achenes glabrous..                                    | <u>A. cordifolius</u>   |
| 11. Rays with eglandular hairs .....  | 12                      |
| Rays without eglandular hairs .....   | 13                      |
| 12. Leaf margin entire, apex acute .....  | <u>A. amellus</u>       |
| Leaf margin toothed, apex obtuse ....   | <u>A. tenebrosus</u>    |

13. All achenes with eglandular biseriate hairs .....	<u>A. acuminatus</u>
No eglandular biseriate hairs on achenes .....	14
14. L/B ratio of leaves 17 or more .....	15
L/B ratio 11 or less (13 in <u>A. punctatus</u> ).....	16
15. Bracts with 1 simple vein, fibres and appendaged hairs; anthers auricled; rosettes in achene and style of D.F..	<u>A. ericoides</u>
Bracts with many branched veins, no fibres and no appendaged hairs; anthers not auricled; no rosettes in achene and style of D.F. ....	<u>A. linosyris</u>
16. Plant stemless .....	<u>A. macrophyllus</u>
Stem present .....	17
17. Leaves conspicuously petioled .....	18
Leaves sessile or decurrent .....	21
18. Pappus apex 2-celled; rosettes in testa; rosettes and prismatic in style of R.F. ....	<u>A. lowrieanus</u>
Pappus apex $\infty$ -celled; no rosettes in testa; no crystals in style of R.F...	19
19. Rosette crystals in all achenes, and in style of R.F. ....	20
Rosettes absent in the same organs...	<u>A. undulatus</u>
20. Anthers auricled; prismatic in achenes .....	<u>A. divaricatus</u>
Anthers not auricled; no prismatic in achenes .....	<u>A. sagittifolius</u> f. <u>hirtellus</u>
21. Anthers auricled .....	22
Anthers not auricled .....	27
22. Glandular hairs on petals and achenes absent, no prismatic in style .....	<u>A. radula</u>
Glandular hairs on petals and achenes present; prismatic in style present.	23
23. Pappus apex 2-celled; bracts without glandular hairs .....	24
Pappus apex $\infty$ -celled; bracts with glandular hairs .....	25

24. Leaf-margin entire; bract with branched vein and no fibres ..... A. novi-belgu  
 Leaf-margin dentate; bract with simple vein and fibres ..... A. prenanthoides
25. L/B ratio 2; pith lignified ..... A. patens  
 L/B ratio 7 or more; pith parenchymatous ..... 26
26. Leaf-margin dentate; no rosettes in achene, prismatic in style present A. salicifolius  
 Leaf-margin entire; rosettes in achene present; no prismatic in style..... A. simplex
27. Capitula in corymbose arrangement.... 28  
 Capitula not corymbose ..... 30
28. Leaf-margin dentate; no canals in stem ... A. spectabilis  
 Leaf-margin entire; canals in cortex. 29
29. Bracts 1-nerved with fibres, glandular and appendaged hairs absent on bracts and petals; pappus apex  $\infty$ -celled... A. acris  
 Bracts  $\infty$ -nerved and no fibres, glandular and appendaged hairs on bracts; petals with glandular hairs; pappus apex 2-celled ..... A. longicaulis
30. Pappus apex  $\infty$ -celled ..... 31  
 Pappus apex 2-celled ..... 32
31. Canals in cortex present; pith lignified, bracts with glandular hairs A. adscendens  
 No canals in stem; pith parenchymatous; bracts without glandular hairs..... A. sagittifolius
32. Bracts with glandular hairs ..... 33  
 Bracts without glandular hairs ..... 35
33. L/B ratio of leaf 12 or more, petals without gland. hairs; no canals in phloem; pith lignified ..... A. punctatus  
 L/B ratio of leaf less than 7; petals with gland. hairs; canals in phloem; pith parenchymatous ..... 34
34. Leaf-apex acute; bracts with fibres.. A. novae-angliae  
 Leaf-apex obtuse; fibres absent..... A. subulatus
35. Leaf-margin entire; rosettes in style of R.F. .... A. laevis  
 Leaf-margin dentate; no rosettes in style of R.F. .... 36

36. L/B 3; prismatic in testa, achene & style. A. lateriflorus  
L/B 8.4, rosettes in testa, achene & style. A. puniceus

## LITERATURE CITED

- Bentham, G. and Hooker, J.D. (1976). Genera Plantarum, II. Reeve, London.
- De Candolle, A.P. (1936). Prodrromus Systematis Regni Vegetabilis. V. Paris.
- Fernald, M.L. (1950). Gray's Manual of Botany, ed. 8. American Book Co., New York.
- Hoffmann, O. (1894). Compositae, in A. Engler and K. Prantl's (eds.) Die naturlichen Pflanzenfamilien, IV-5. Leipzig.
- Merxmuller, H., Schreiber, A. and Yeo, P.F. (1976). Aster L., in T.G. Tutin et al (eds.) Flora Europaea, 4. Cambridge Univ. Press, Cambridge.
- Munz, P.A. (1968). A California Flora. Univ. of California Press, U.S.A.
- Lindley, J. (1853). The Vegetable Kingdom, ed. 3. Bradbury and Evans, London.
- Lippert, W. (1973). Revision der Gattung Aster in Afrika. Mitt. Bot. Staatssamm. Munchen, 11: 153-258.
- Lippert, W. (1980). Aster L., in J. Grau and W. Lippert's the Compositae of the Flora Zambesiaca area. II- Asteraceae (continued). Kirkia, 12(1):1-14.
- Rommel, A. (1977). Die Gattung Amellus L. (Asteraceae-Astereae). Systematischer Teil. Mitt. Bot. Staatssamm. Munchen, 13: 579-728.
- Rommel, A. (1979). Die Gattung Amellus L. (Asteraceae-Astereae). Allgemeiner Teil. Mitt. Bot. Staatssamm. Munchen, 15: 243-329.